The George Washington University
Washington, D. C.

Mecheleciv

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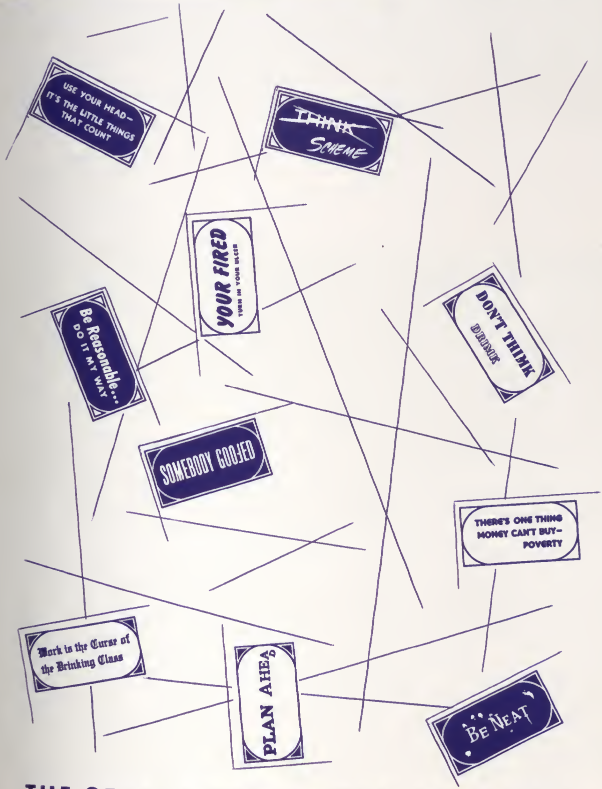

THE GEORGE WASHINGTON UNIVERSITY

APRIL 1964

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At the 1963 stockholders' meeting, Arjay R. Miller, President of Ford Motor Company, emphasized the Company's far-sighted recruitment program and its accent on developing management talent:

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"The program is paying off. We have developed a real depth of management talent in the Company, and we are dedicated to seeing it continued and reinforced. Because of this, I feel not only very fortunate in being associated with this management group, but also very confident of its long-run success. We know our goals and how to achieve them."

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Arjay R. Miller, President of Ford Motor Company, and Henry Ford II, Chairman of the Board, at 1963 Annual Stockholders' Meeting.

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the Mecheleciv

VOLUME 22 APRIL - 1964 No. 5

THE REGULAR page

THE SPECIAL

THE EXTRA SPECIAL

THE COVER

The cover is an illustration done to give the reader an insight into the bywords of the engineer, bywords which led to the # @ * & % ¢ that you will find in the April issue of the MECHELECIV.

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"ARE WE POLITICAL PAWNS?"

The results of the recent Student Council elections are, by now, well known to students of this university.

Mr. Victor Clark was elected to the position of the student governing body's president for one full year. Messrs. Laycock, Gnehm, and Rankin were elected by their respective groups as the representatives of those groups, also for one full year.

During the campaign, each of these four students, as well as all the other candidates, was asked to state his opinions on several issues, some of which directly affect each and every student that he would represent. I am concerned only with the responses given on the activities fee question. Clark, Laycock, Gnehm, and Rankin ALL expressed an unfavorable attitude toward the fee; Mr. Clark even went so far as to express his opinion FOR THE RECORD. Yet, as we all know, when they were asked to reaffirm their dissent at the Student Council "showdown" on the matter, they all reversed their stand.

Questions such as "Why" were answered:

". . . opposition during the campaign was directed at the specific Fee proposed last year, not fees in general."

This attitude is fine, except for one "minor" detail: the activities fee in question was THIS year's proposed fee, not LAST year's. And displays such as this flagrant disregard for those students that they will represent have no place on a college campus. These four students were elected on the basis of the opinions they expressed against, supposedly, the proposed activities fee for THIS year. Surely this must compel them to vote as their electors voted in supporting them.

If these students are not to be held to the views of those whom they represent, why, then, do we even bother with elections? Why do we call them REPRESENTATIVES? If, after all, their views during elections need not necessarily reflect the views that they will support during their terms of office, why should the rest of the students take even the slightest interest in the Student Council -- or its "representatives."

If Clark, Laycock, Gnehm, and Rankin are going to be the REPRESENTATIVES of their electors, then let them carry out, to the full "letter of the law", the meaning of the word.

Judith J. Popowsky

PROFESSOR SPOTLIGHT

Dr. Morris S. Ojalvo

Dr. Morris S. Ojalvo, Professor of Mechanical Engineering at The George Washington University School of Engineering and Applied Science, is another example of the outstanding faculty of the engineering school. Dr. Ojalvo received his Bachelor's degree in mechanical engineering from Cooper Union, his M.M.E. from the University of Delaware, and his Ph.D. from Purdue University. During his education, Dr. Ojalvo was admitted membership in Tau Beta Pi, Pi Tau Sigma, and Sigma Xi national honorary fraternities.

Dr. Ojalvo is not new in the teaching field. Before coming to G.W.U. in 1960, he taught at Pennsylvania State University, the University of Illinois, the University of Maryland, the University of Delaware, and Purdue University. He has also done consultant work and has worked on numerous research projects. Besides all this, Dr. Ojalvo has written many technical papers, some of his work appearing on both radio and television.

At G.W.U., Dr. Ojalvo teaches both graduate and undergraduate courses in Thermodynamics, Heat Transfer, Thermal Power, and Fluid Dynamics. In graduate courses, he lectures from notes concerning modern practical aspects of the subject matter, and he uses a text only for reference and clarification of the subject matter. In his undergraduate courses, he requires a text and he lectures on matters peripheral to the text. He also attempts to clarify difficult points that the text makes, and he very capably answers any questions the students may have about the material. G.W.U. has found still another outstanding professor, Dr. Morris S. Ojalvo.

DARKNESS FOREVER DAYLIGHT

by J. J. P.

INTRODUCTION

Perhaps the most intriguing mystery being investigated by scientists is the extent of the Universe in which we live. The aspects of this question have been tossed about for centuries, with a resulting outcrop of numerous and varied theories and opinions. Generally, these theories fall into two categories: that the Universe is finite but unbounded, or, that the Universe is infinite in extent.

And, to support each of these general concepts, the reasons themselves spread from the infinite to the bounded in logic and probability. One such proposed "philosophy" is that the Universe is finite but unbounded because, if the Universe were infinite in extent, the night sky would be illuminated almost to, if not to, the brightness of daylight.

Although having neither the knowledge nor the background to submit reasons for either a finite or an infinite Universe, the writer cannot agree with this particular argument for a finite unbounded Universe, and proposes to prove this reason is invalid.

It should be noted that, since the writer will at no time consider a velocity aspect of the stars, the arguments presented may apply to either a static or an expanding Universe.

TO ILLUMINATE THE NIGHT

Of the multiple theorems, ideas, philosophies, and general conversation that might have some bearing on the arguments to come, only one need be considered: the constancy of the speed of light. Accordingly, the proof is presented in two distinct sections: Theory One -- The Speed of Light is Constant; Theory Two -- The Speed of Light is Changing. Of necessity, the first theory is treated in two cases: Case I -- the increase in wavelength of the light being considered; Case II -- the decrease in wavelength of the light being considered.

THEORY I

There are two basic assumptions that can be made. One is that the speed of light remains constant with respect to all possible variables. The other depends upon the case to be considered, as mentioned previously.

Case I

Light, or more exactly, light waves, are considered by today's authorities to be streams of photons, infinitessimal particles having a very minute charge. When light waves, or photon streams, collide with other particles, new photons are emitted, having less energy and a longer wavelength than the incident photons (this phenomenon is attributed to the Compton Effect).

Let us assume that space, i.e., interstellar and interplanetary space, is occupied by dust and other particles, all or most of which can be broken down by some means into charged particles.

According to the Compton Effect, every time a light wave (or photon stream) hits one of these "spacial" particles, slower photons with longer wavelengths are emitted. Logically, the more particles encountered by the photon stream, the longer the wavelength of the final stream becomes. Accordingly, the greater the distance between us and any star, the more particles the emitted light waves from that star would hit, etc.

Mathematically, the above argument can be stated as follows: Let λ be the wavelength of the light at the time it is emitted from the star in question. Let λ_0 be the wavelength of the light wave when it reaches the earth.

Energy, i.e., the total energy of the combined particles in the photon stream, is related to the wavelength of the light by the relation,

$$E = \frac{hc}{\lambda} = \frac{0.00124}{\lambda}$$

where, E is measured in Mev
λ is measured in Angstrom units.

A quick-look analysis of this equation leads to the conclusion that an increase in the wavelength, $\Delta\lambda$, would cause a decrease in the energy.

This can be further explored. The following definitions are used:

E_o = original energy of light wave

E = final energy of light wave

ΔE = change in energy of the light wave

λ_0 = original wavelength of light wave

λ = final wavelength of light wave

$\Delta\lambda$ = change in wavelength of the light wave

If ΔE is negative, i.e., if the energy of the photon stream decreases, then $\Delta\lambda$ will also be negative, since the other two quantities in the equation for E (or for ΔE) are positive.

Simple mathematics tells us that,

$$E = E_o + \Delta E$$

Substituting from the general equation for energy, we get,

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{hc}{\Delta\lambda}$$

(A condition placed on the above is that E_o be greater than $|\Delta E|$. If this condition were not imposed, it might be mathematically conceivable for E to be negative, a physical impossibility.)

This equation reduces to:

$$\lambda = \frac{\lambda_0\ \Delta\lambda}{\lambda_0 + \Delta\lambda}$$

(Again, a condition is placed on this equation. Simply stated, this condition is that

$$\left|\frac{hc}{\Delta\lambda}\right| < \left|\frac{hc}{\lambda_0}\right|$$

or,

$$|\Delta\lambda| > |\lambda_0|$$

according to this mathematical discussion, then, λ must always be greater than λ_0, for the case when $\Delta\lambda$ is negative, i.e., when ΔE is negative. In other words, when the energy is decreased by impact or collision, the wavelength must increase.

It is therefore not logical to assume that the wavelength of the light that reaches the earth will still be in the visible range. Rather, it is more logical to believe that the wavelength will be beyond the visible range, shifting toward the red and infrared ranges as the distances between us and the stars increase according to the particular star being examined.

Case II

Again, it is assumed that the speed of light remains constant with respect to all possible variables. This time, however, instead of considering the number of particles between us and the emitting star being examined, let us consider that all stars are presupposed to have magnetic fields associated with them. Since photons are charged particles, they should be affected by such magnetic fields.

As before, the original energy of the photon stream is taken to be E_o. As the photons pass through various magnetic fields on their way to earth, they receive a minute increase in energy, thus causing a corresponding acceleration in photon stream speed. Going back to the equations used for the first case in Theory One, we see that ΔE is positive; hence, $\Delta\lambda$ is positive. It is, of course, necessary to impose the same conditions on the resulting equations whose derivations do not hinge on the positive or negative character of the variables. Restating the final equation to be considered,

$$\lambda = \frac{\lambda_0\ \Delta\lambda}{\lambda_0 + \Delta\lambda}$$

where,

$$|\Delta\lambda| > |\lambda_0|$$

Since, for this case, $\Delta\lambda$ is positive, then λ must always be less than λ_0.

Logic tells us that the greater the distance through which the wave must travel, the more numerous the magnetic fields it will encounter on its way. And, the more fields it encounters, the greater will be the resulting decrease in the wavelength of the photon stream. Even less logic is needed to imply that this wavelength is more likely to be decreased toward the violet "phase" of light than it is possible to remain in the very limited visible range.

CONCLUSIONS NUMBER 1:

The arguments that have thus far been put forward have considered that the speed of light is constant. Examination of the arguments shows that the direction (positive or negative) of the change in light wavelength has but one effect on

--Continued on Page 14

CAMPUS HIGHLIGHTS

As most of us know, the month of April is the time for elections in the organizations around our school. So it is that the following elections announcements are made:

ENGINEERS' COUNCIL OFFICERS

President	Lee "Chip" Young	Intermediate Level Rep.
Vice President	Harold Freed	Advanced Level Rep.
Secretary	John Scott	ASCE Rep.
Assistant Secretary	Perry Saidman	Intro. Level 2nd Year Rep.
Treasurer/Business Manager for Mecheleciv	Judith Popowsky	IEEE Rep.

THETA TAU OFFICERS

Regeant	Vance Cribb
Vice Regeant	Larry O'Callahan
Scribe	Gordon Davison
Assistant Scribe	Frank Moy
Treasurer	Lee "Chip" Young
Corresponding Secretary	Millard Carr
E. C. Rep.	Robert Mullen

As yet, not all of the societies have had elections of new officers; this means that future election results will be published in the May issue of the MECHELECIV.

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THERMOELECTRICITY -- PRACTICAL APPLICATIONS

by John Nemechek

Tau Beta Pi Pledge Essay

Thermoelectricity is a well-known phenomenon; however, the progress made in its application by solving practical problems is still restricted to engineers and scientists. During the past year several scientific periodicals have published articles about research and achievements in this field, and all of them have pointed out that new, important discoveries are to be expected.

The experimental discovery of thermoelectricity dates from the early years of the last century. The Seebeck potential, or thermoelectric force, is the electric current produced in a circuit of two dissimilar elements (see Fig. 1) when one junction is heated relative to the other. The temperature difference created between the junctions is a means of converting thermal energy into electrical energy in the form of an electromotive force (emf). In recent years,

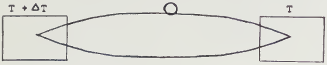


FIGURE 1

considerable attention has been devoted to finding materials in which this thermoelectric conversion takes place with an efficiency high enough for practical purposes.

The efficiency of thermoelectric generation depends on the temperature of the cold and hot junctions multiplied by the figure of merit (Z) defined as:

$$Z = \frac{\sigma S^2}{K}$$

where S is the Seebeck (thermoelectric) coefficient of the two dissimilar elements (called thermocouple), σ (sigma) is the electrical conductivity, and K is the thermal conductivity. This means that a material is suitable for thermoelectric conversion if it can stand high temperature differences, and if its Seebeck coefficient and electrical conductivity are as high as possible while its thermal conductivity is as low as possible.

Experiments with silver and gold at very low temperatures of 1 to 0.5°K showed a thermoelectric potential of 4×10^{-9} volts per °K, which can be considered negligible. Yet other experiments with a much purer gold specimen showed a thermoelectric force 1000 times greater. Thermocouples of InSb and InAs at 500 to 700°C generate power with an efficiency of about 6%; and this figure can be improved by decreasing the thermal conductivity. Other materials, such as Bi_2Te_3, have figures of merit considerably larger;

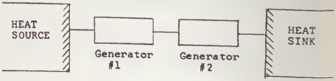


FIGURE 2

however, they can only be used at low temperatures. It will be interesting to see whether or not any other metal or group of metals will show thermoelectric potentials of greater magnitudes.

The efficiency of thermoelectric generation can be increased by connecting the generators in thermal series, as shown in Fig. 2.

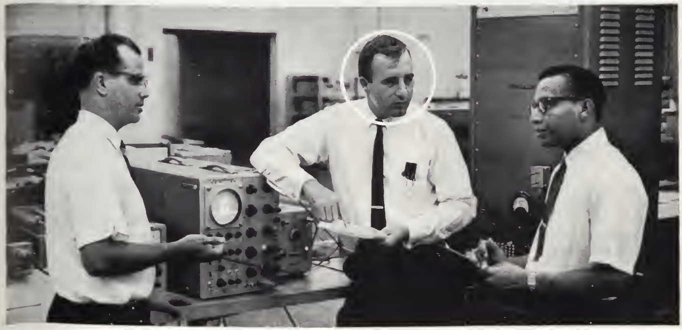
Another device for thermoelectric power generation is the so-called "Thermoelectric Engine", invented at the Massachusetts Institute of Technology. It consists of two metallic plates spaced 10^{-3} inches apart in a vacuum; one plate is heated to about 2200°F, while the other is maintained at 1000°F. The present thermal efficiency of this device is 12%, but there are no fundamental reasons for not increasing this efficiency to 30% or more.

Thermoelectricity has been applied with practical significance in various fields of science and engineering. Experiments conducted at Shell Oil proved that the use of thermocouples on heater and boiler tubes results in better accuracy and longer life of the tubes. Special thermocouples are used as tools and techniques for measuring surface temperatures on thin metal sections for solving problems in aeronautics and space. Thermocouples are successfully used in devices for thermal monitoring and control of jets and rockets. Other fields in which thermoelectricity is applied are: calorie-meters, infrared-ray detectors, temperature measurement in engines with internal combustion, humidity measurement, iron and steel processing plants, and textile mill instruments.

The future of thermoelectricity lies in its simplicity, because a thermoelectric generator has no moving or complicated parts. It can use heat energy from any source: coal, oil, gas, atomic energy, solar energy, heat from the interior of the earth, etc. A combination of solar energy with thermocouples looks like the ideal way to supply the future space ships with electricity.

The most important aspect of thermoelectricity lies, however, in the fact that the earth's resources of "conventional" fuels are limited, and one day we will face the problem of using sources of energy that, as of today, are beyond our reach.

Tom Huck sought scientific excitement



He's finding it at Western Electric

Ohio University conferred a B.S.E.E. degree on C. T. Huck in 1956. Tom knew of Western Electric's history of manufacturing development. He realized, too, that our personnel development program was expanding to meet tomorrow's demands.

After graduation, Tom immediately began to work on the development of electronic switching systems. Then, in 1958, Tom went to the Bell Telephone Laboratories on a temporary assignment to help in the advancement of our national military capabilities. At their Whippany, New Jersey, labs, Tom worked with the Western Electric development team on computer circuitry for the Nike Zeus guidance system. Tom then moved on to a new assignment at WE's Columbus, Ohio, Works. There, Tom is working on the development of testing circuitry for the memory phase of electronic switching systems.

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the light that finally reaches earth -- the light is either above or below the visible range.

This, however, does not complete the proof.

THEORY TWO

In Theory One, the speed of light was considered constant. However, this presumption could be (and has been) argued against. Let us, then, consider that the speed of light is changing.

To be more specific, let us say that the speed of light is changing according to the relation:

$$c \propto \frac{1}{d}$$

where, c = the speed of light
d = the distance from the star in question to the earth

It is also known that

$$E \propto c$$

Using this last relation, a simple analysis shows us that, as c decreases, so must E decrease.

Let's retrace our steps. Another relation that we must consider is

$$E \propto \frac{1}{\lambda}$$

A simple analysis of this equation leads to the conclusion that an increase in λ must be caused by a decrease in E.

Now, put all of the above conclusions together. One gets the simple result that an increase in the distance of the star from the earth would cause a decrease in the speed of light. This would create a corresponding decrease in the energy E, and, in turn, the wavelength λ would have to increase.

Here again, any considerable distance between us and the star would cause the wavelength to go beyond the visible range into the red and infrared ranges.

GENERAL CONCLUSIONS

Since the range of human sensitivity to light is only from about 400 to 700 mμ (1 mμ = 1 millimicron = 10^{-9} meters), as compared to the total range of light detection of from 10^{-14} to 10^{+7}, the probability of light from a star reaching the earth while the wavelength of this light is still in the visibility range is not too great.

In fact, in order for this to occur, the star would have to be within a certain distance from the earth (dependent upon the wavelength of the light it emits), and the conditions of the space through which its light travels would have to be particularly favorable toward producing the effects described in the theories I have presented.

The small pinpoints of light visible on a clear night are an ample testimony to the fact that, in many many cases, the conditions illustrated above do exist; but the dark, black vastness that surrounds these pinpoints proves the validity of the writer's arguments that an infinite Universe does not presuppose a "darkness" that is forever daylight.

CLOSING NOTES

It should be remembered that the purpose of these arguments is not to prove the extent of the Universe. It is, as it should be, to invalidate the theory that the night sky would be as bright as daylight were the Universe to be infinite.

* * * * * * * * * * * * *

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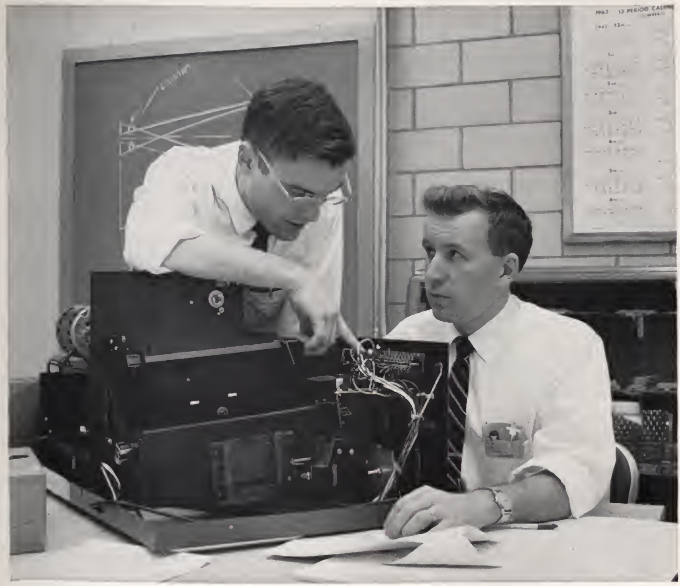

After McNair designs it, Kelly has to manufacture it

In the broad spectrum of engineers and scientists we constantly seek, we can use more manufacturing engineers like Edward Joseph Kelly (right, six years out of Tufts this June). Mark well the distinction between Kelly's responsibility and that of his opponent in the debate pictured. Out of it upon completion of their differing assignments will come a photographic information storage and retrieval device that will bear our "Recordak" trademark, well known in banking and other businesses.

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Define Your Career Objectives!

■ An interview with W. Scott Hill, Manager—Engineering Recruiting, General Electric Co.

W. Scott Hill

Q. Mr. Hill, when is the best time to begin making decisions on my career objectives?

A. When you selected a technical discipline, you made one of your important career decisions. This defined the general area in which you will probably begin your professional work, whether in a job or through further study at the graduate level.

Q. Can you suggest some factors that might influence my career choice?

A. By the time you have reached your senior year in college, you know certain things about yourself that are going to be important. If you have a strong technical orientation and like problem solving, there are many good engineering career choices in all functions of industry: design and development; manufacturing and technical marketing. If you enjoy exploring theoretical concepts, perhaps research—on one of the many levels to be found in industry—is a career choice to consider. And don't think any one area offers a great deal more opportunity for your talent than another. They all need top creative engineering skill and the ability to deal successfully with people.

Q. After I've evaluated my own abilities, how do I judge realistically what I can do with them?

A. I'm sure you're already getting all the information you can on career fields related to your discipline. Don't overlook your family, friends and acquaintances, especially recent graduates, as sources of information. Have you made full use of your faculty and placement office for advice? Information is available in the technical journals and society publications. Read them to see what firms are contributing to advancement in your field, and how. Review the files in your placement office for company literature. This can tell you a great deal about openings and programs, career areas and company organization.

Q. Can you suggest what criteria I can apply in relating this information to my own career prospects?

A. In appraising opportunities, apply criteria important to you. Is location important? What level of income would you like to attain? What is the scope of opportunity of the firm you'll select? Should you trade off starting salary against long-term potential? These are things you must decide for yourself.

Q. Can companies like General Electric assure me of a correct career choice?

A. It costs industry a great deal of money to hire a young engineer and start him on a career path. So, very selfishly, we'll be doing everything possible to be sure at the beginning that the choice is right for you. But a bad mistake can cost you even more in lost time and income. General Electric's concept of Personalized Career Planning is to recognize that your decisions will be largely determined by your individual abilities, inclinations, and ambitions. This Company's unusual diversity offers you great flexibility in deciding where you want to start, how you want to start and what you want to accomplish. You will be encouraged to develop to the fullest extent of your capability—to achieve your career objectives, or revise them as your abilities are more fully revealed to you. Make sure you set your goals realistically. But be sure you don't set your sights too low.

FOR MORE INFORMATION on G.E.'s concept of Personalized Career Planning, and for material that will help you define your opportunity at General Electric, write Mr. Hill at this address: General Electric Co., Section 699-10, Schenectady, N. Y. 12305.

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